

# Controlling the magnetic properties of nanoscale antiferromagnets

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The emergence of antiferromagnetic (AFM) spintronics has opened new avenues for next-generation magnetic memory and logic devices, offering advantages such as ultrafast dynamics, negligible stray fields, and robustness against external magnetic perturbations.[1] However, realizing the full potential of AFM materials requires precise control over their magnetic properties at the nanoscale, including spin orientation, magnetic ordering temperature, and interfacial exchange coupling. This presents significant challenges, as antiferromagnets lack net magnetization and are thus difficult to characterize and manipulate using conventional magnetometry techniques. In this study, we explore how different external factors can modulate the magnetic state of antiferromagnets. We demonstrate three distinct approaches for controlling AFM properties: (i) exchange coupling with adjacent ferromagnetic layers,[2] (ii) epitaxial and piezoelectric strain from buffer layers or ferroelectric substrates,[3],[4] and (iii) magnetic proximity effects between neighboring antiferromagnetic materials.[5] Using epitaxially grown heterostructures including FeO/CoO, NiO/MgO/Cr, Co/NiO/Fe, and Fe/CoO on PMN-PT substrates, we show that each modulation mechanism provides unique capabilities for engineering antiferromagnetic order. Our findings demonstrate that rational design of AFM heterostructures through controlled selection of neighboring layers and substrates provides versatile routes for engineering antiferromagnetic properties. This work advances both fundamental understanding of interfacial magnetism and practical pathways toward AFM-based spintronic devices.

## References:

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